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Docket No. YOR920030175US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**Patent Application**

Applicant(s): Allen et al.
Case: YOR920030175US1
Serial No.: 10/661,041
Filing Date: September 12, 2003
Group: 2811
Examiner: Cuong Q. Nguyen

Title: Techniques for Patterning Features in Semiconductor Devices

AFFIDAVIT UNDER 37 C.F.R. §1.131

We, the undersigned, hereby declare and state as follows:

1. We are the named inventors of the above-referenced U.S. patent application.

2. On or around November, 2000, we prepared the enclosed document (labeled "Exhibit 1") that evidences a reduction to practice of an invention falling within one or more of the claims of the above-referenced application (Exhibit 1 was created on November 9, 2000).

3. On page 3 of Exhibit 1, an image is shown (situated on the left-hand side of page 3) (hereinafter "the image") that illustrates etching through a photoresist layer (top layer), an antireflective material layer (middle layer) and a portion of a substrate layer (lower layer).

4. As is shown in the image, a critical dimension reduction occurred during etching of the antireflective material layer. This is further evidenced by the caption to the image, which indicates a -30 nanometer critical dimension bias.

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5. As shown in the image, critical dimension reduction occurred during etching of the antireflective material layer, as etching is shown to have ceased just following passage through the antireflective material layer.

6. We prepared the enclosed document (labeled "Exhibit 2") that is evidence of continued efforts in evaluating embodiments of the invention.

7. Exhibit 2 (pages 1-4) contains evaluation images of the evaluation results that were obtained from May to August, 2003. The date of the evaluation result is indicated in the upper right corner of each evaluation image.

8. All statements made herein of our own knowledge are true, and all statements made on information and belief are believed to be true.

9. We understand that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001, and may jeopardize the validity of the application or any patent issuing therefrom.

Date: 11/1/05
Scott D. Allen

Date: _____

Katherina E. Babich

Date: _____

Steven J. Holmes

Docket No. YOR920030175US1

Date: 11-1-2005

Arpan P. Mahorowala
Arpan P. Mahorowala

Date: _____

Dirk Pfeiffer

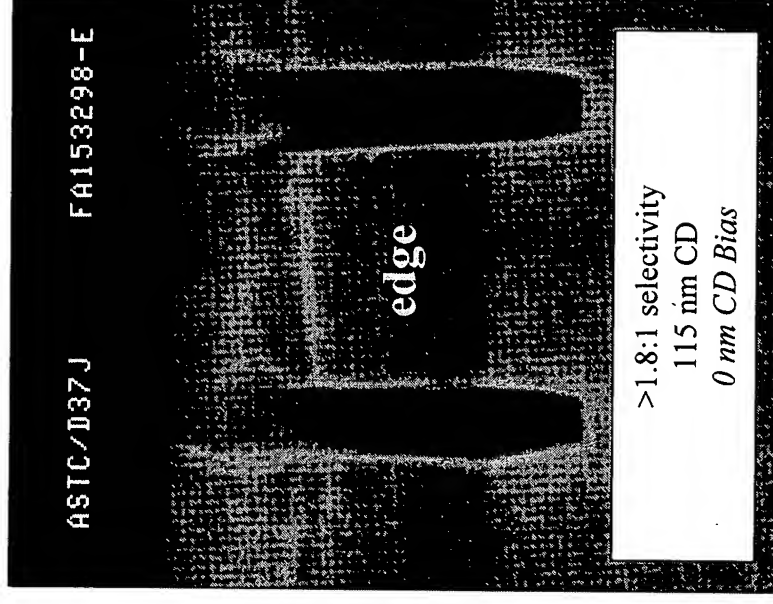
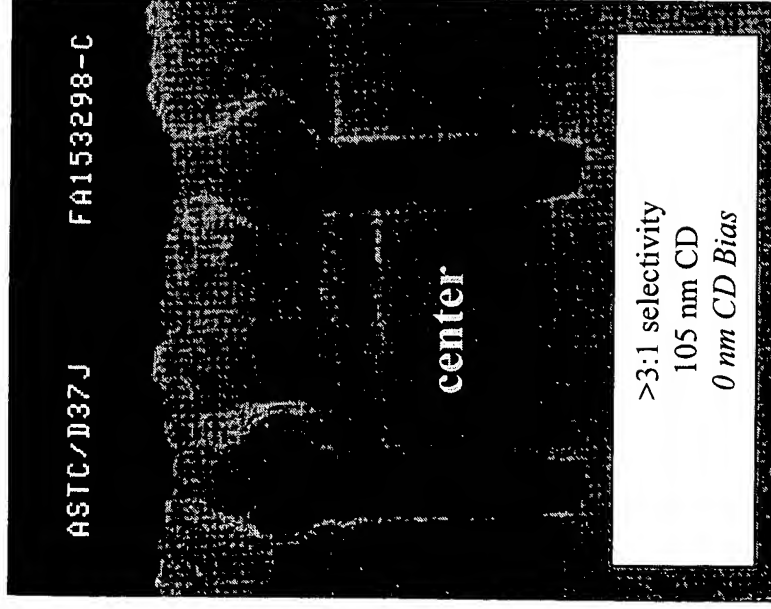
Date: _____

Richard Stephan Wise

PAR-710 Resist
(350 nm post develop)
300 nm TERA

TERA Development

Fluorocarbon Open Etch Processes - CHF₃ Base



TEL 85 Process:
SiC: 60 secs / 40 mT / 1.4kW / 5 C₄F₈ / 10 CHF₃ / 100 N₂ / 5 O₂ / 150 Ar

=> Increase τ_{RES} results in much improved c/e distribution, lower overall selectivity
=> Too much polymer in center, decrease τ_{RES} to improve profile (CGF system)

DRAM DEVELOPMENT ALLIANCE

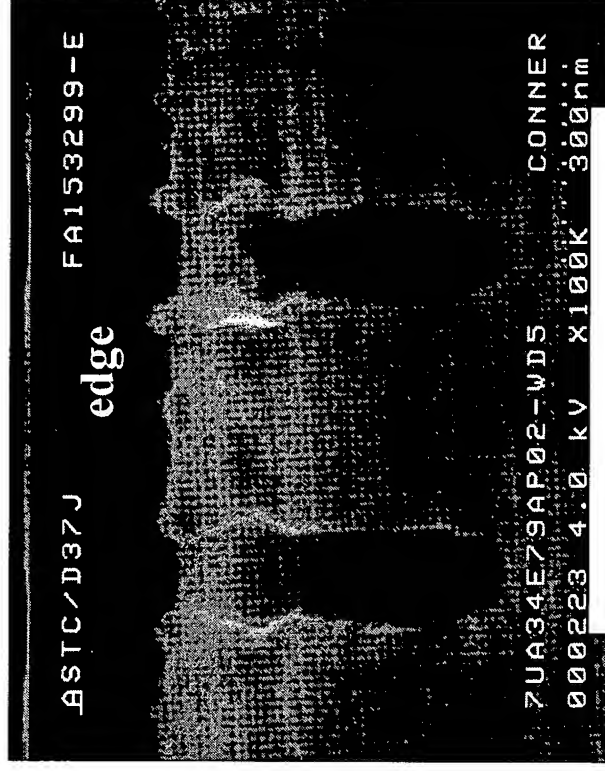
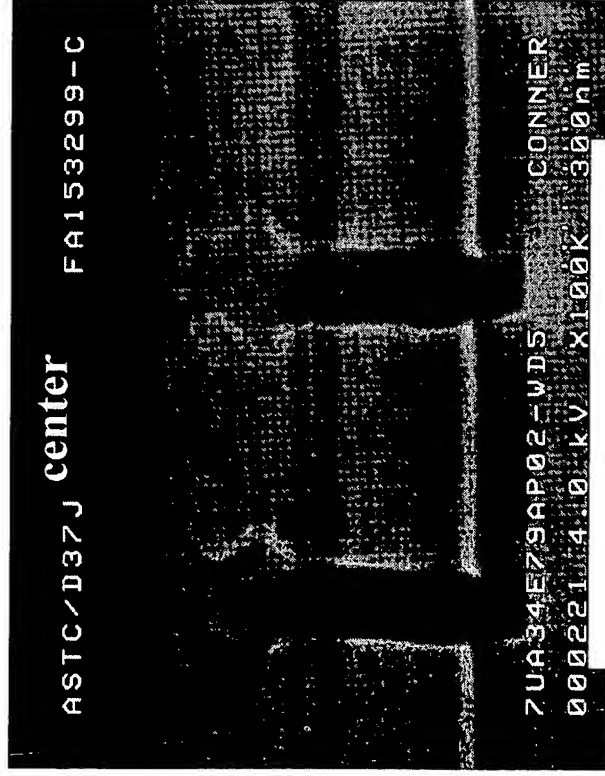
PAR-710 Resist

(350 nm post develop)

300 nm TERA

TERA Development

Fluorocarbon Open Etch Processes - CH_2F_2 Base



TEL 85 Process:

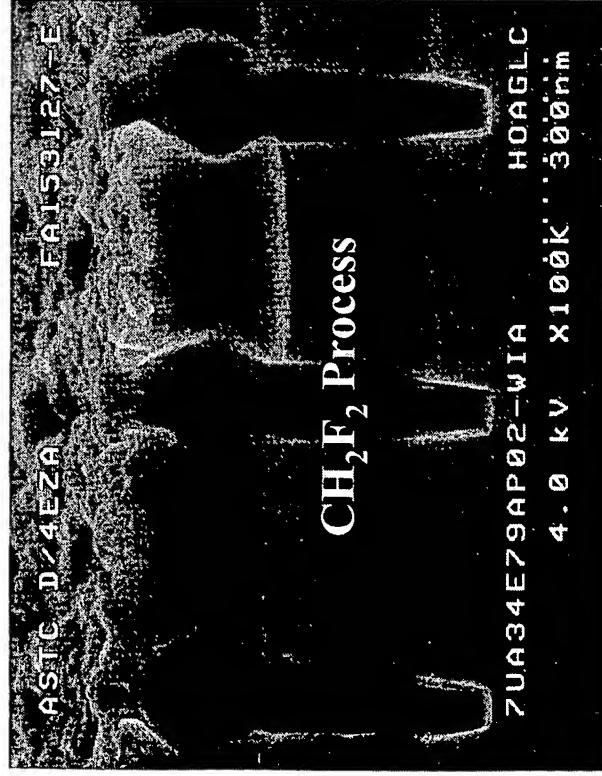
SiC: 60 secs / 40 mT / 1.4kW / 4 C_4F_8 / 10 CH_2F_2 / 100 N_2 / 5 O_2 / 200 Ar

=> Addition of 20% N_2 , reduction 20% C_4F_8 to CH_2F_2 base chemistry eliminated previous CD bias
=> Much reduced selectivity (extreme sensitivity to C_4F_8 flow)

DRAM DEVELOPMENT ALLIANCE

PAR-710 Resist
300 nm TERA

TERA Development F Open Etch Processes

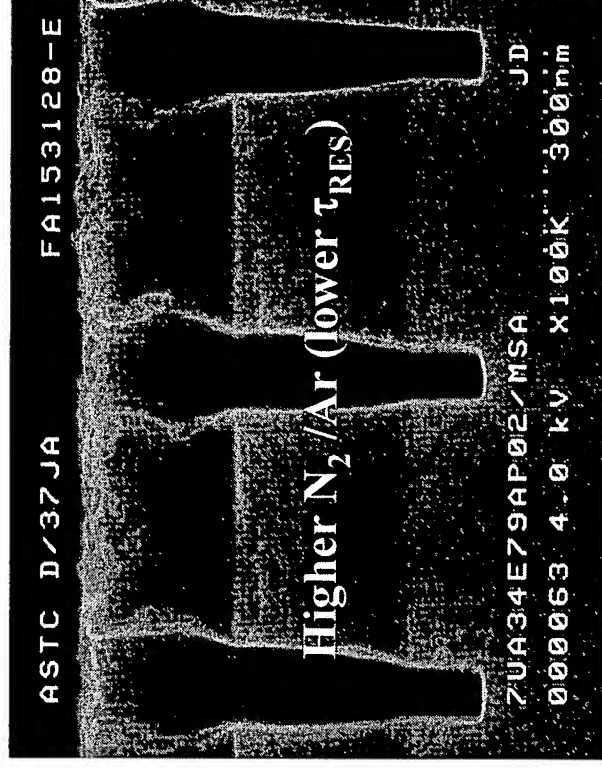


>2:1 selectivity
(200 nm PR + 80 nm Polymeric Cap)
-30 nm CD Bias (c/e similar)

TEL 85 Process:

SiC: 60 secs / 40 mT / 1.4kW / 5 C₄F₈ / 10 CH₂F₂ / 80 N₂ / 5 O₂ / 200 Ar

- => Reduce CH₂F₂ flow (less polymer)
- => Flatten profile (similar to earlier experiments)
- => Reduce CD Bias



>2:1 selectivity
(220 nm PR Remains)
-20 nm c CD Bias, -120 nm e CD Bias

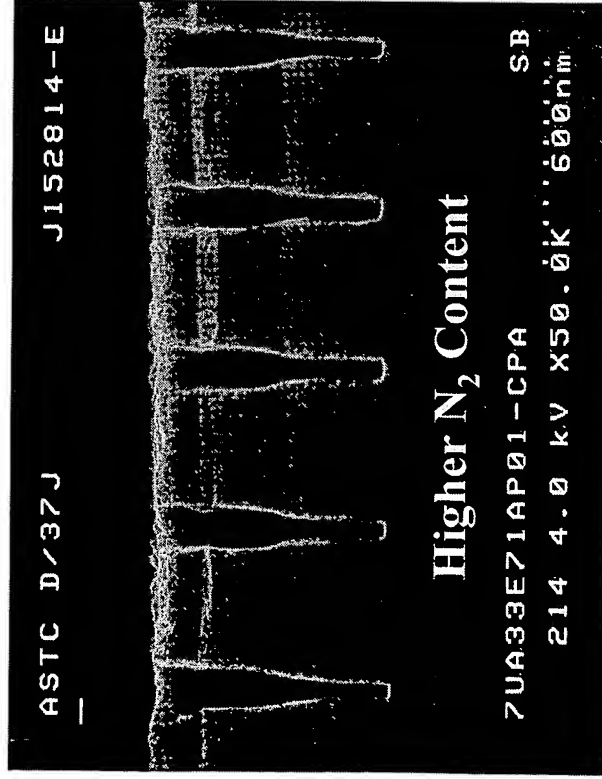
TEL 85 Process:

SiC: 60 secs / 40 mT / 1.4kW / 5 C₄F₈ / 10 CHF₃ / 100 N₂ / 5 O₂ / 250 Ar

- => Increase τ_{RES} (Ar/N₂ flow) (based on previous)
- => Flatten profile (similar to earlier experiments)
- => Reduce CD Bias

PAR-710 Resist
300 nm TERA

TERA Development F Open Etch Processes

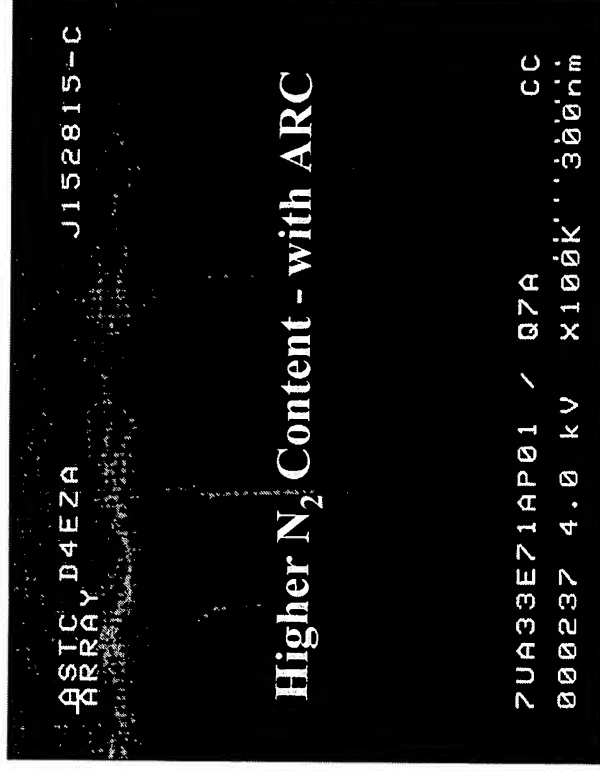


>1.4:1 selectivity
(370 nm into BSG)
center just etch, low CD

TEL 85 Process:

SiC: 90 secs / 40 mT / 1.4kW / 5 C₄F₈ / 10 CHF₃ / 80 N₂ / 5 O₂ / 200 Ar

- => Continue N₂ increase
- => Tune c/e overetch
- => Flatten profile (similar to earlier experiments)



>1.4:1 selectivity
(190c, 300e nm into BSG)

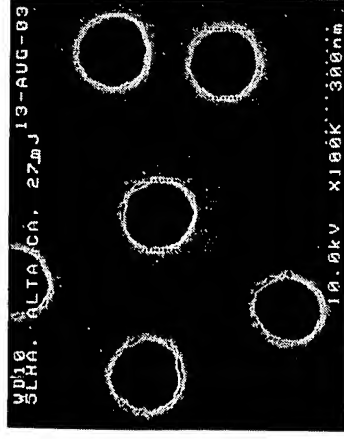
TEL 85 Process:

ARC: 90 secs / 150 mT / 500 W / 10 O₂ / 500 Ar / 20 CH₃F₂
SiC: 90 secs / 40 mT / 1.4kW / 5 C₄F₈ / 10 CHF₃ / 80 N₂ / 5 O₂ / 200 Ar

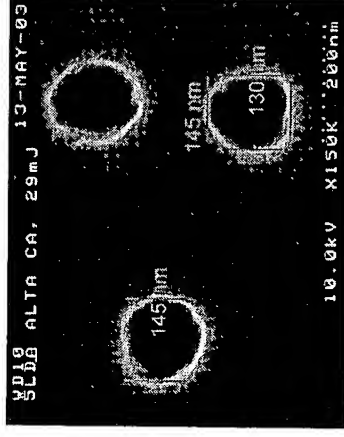
Modified Si ARC Open

Exhibit 2

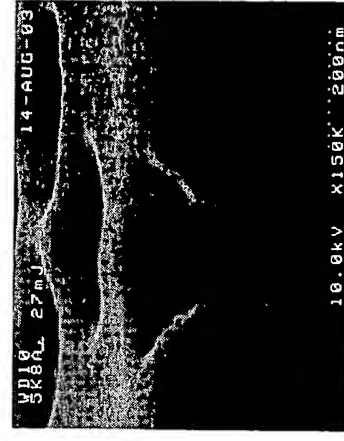
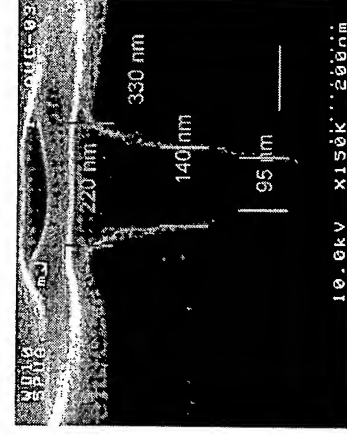
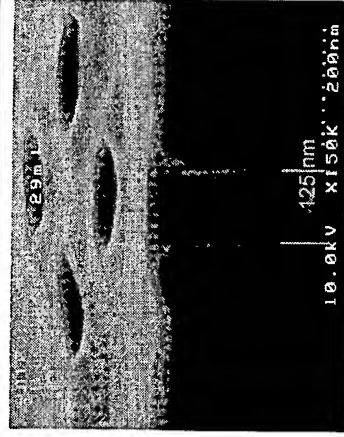
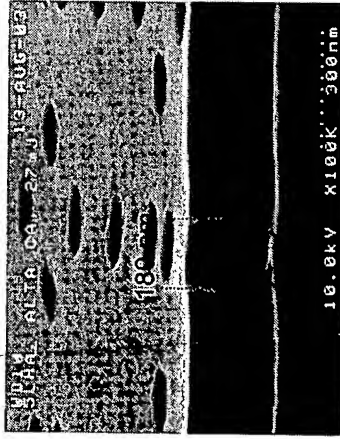
Litho



Si ARC Open



Si ARC Open



5LDA

140 mT, 750/750 W,
3 O2, 200 N2 / 30 s

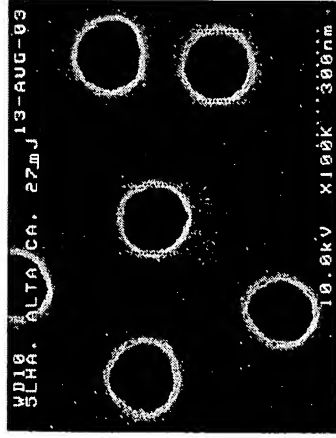
5PUA

140 mT, 750/750 W,
3 O2, 200 N2 / 60 s

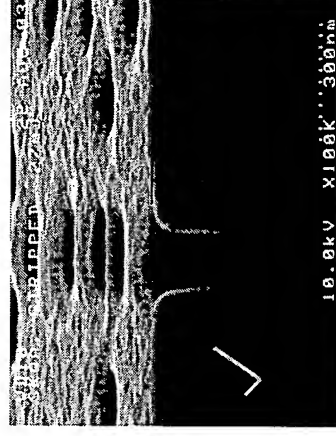
5K8A

5PUA + 45 s CA?
(Scott, Please verify)

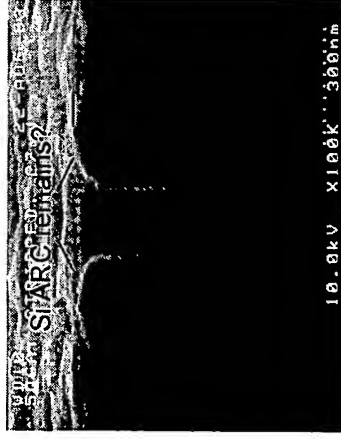
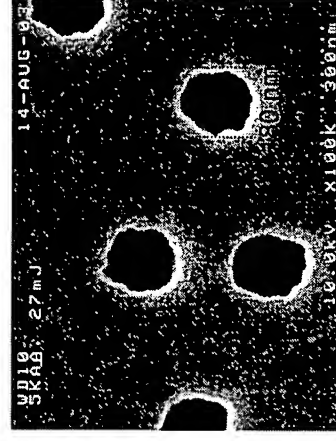
- CA holes appear to shrink initially during Si ARC open
 - Top CD greater than bottom CD?
- Later taper develops in profile and resist CD is blown
 - Repeat w/ another resist (SAIL instead of C5K)
- Cannot explain oxide etch !!



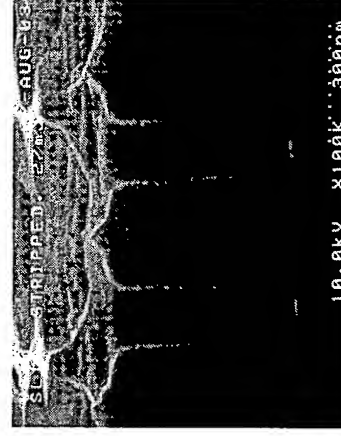
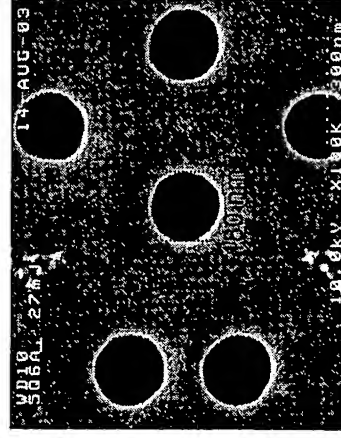
Litho



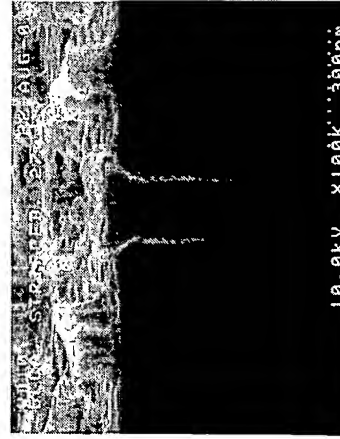
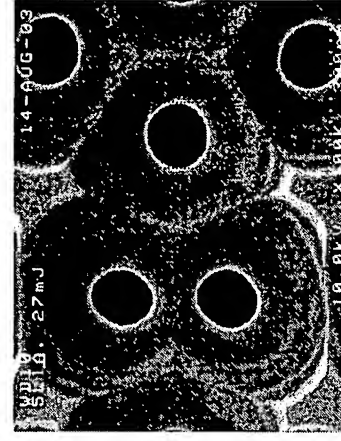
5KAA / SO(40s) + CA + N2/H2 PET (30/10) + cap
Etch depth ~ half; something wrong?



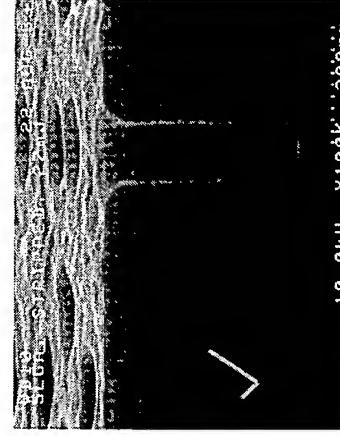
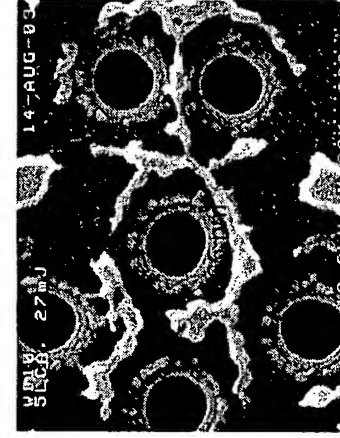
5Q6A / SO(40s) + CA + N2/H2 PET(30/0) + cap
Non-biased PET promising!



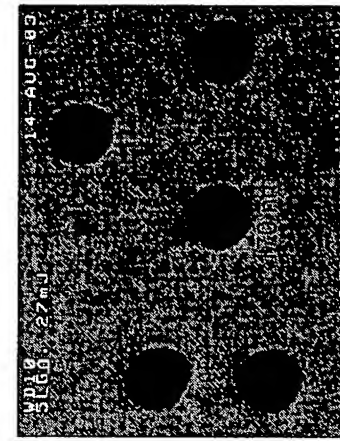
5LIA / SO(40s) + CA + N2/H2 PET (30/10)+ other nitride etch
No good

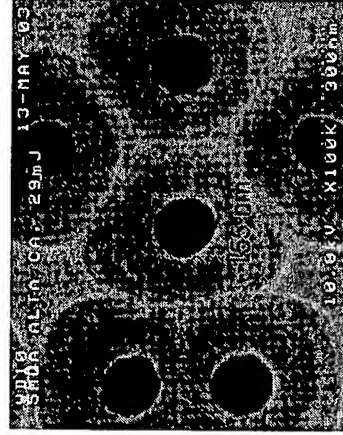
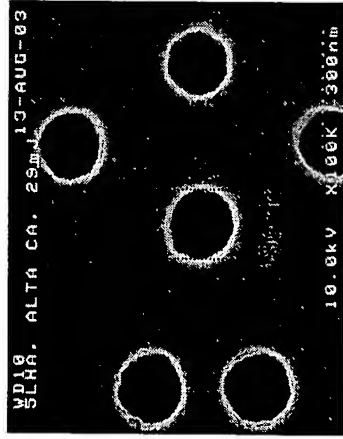


5LCA / SO(40s) + CA + PR strip + cap
Si ARC top "fully oxidized"; "residue" not consumed during cap etch?

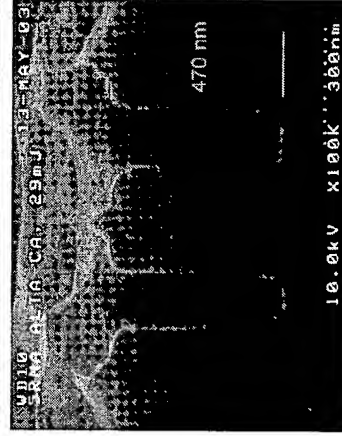
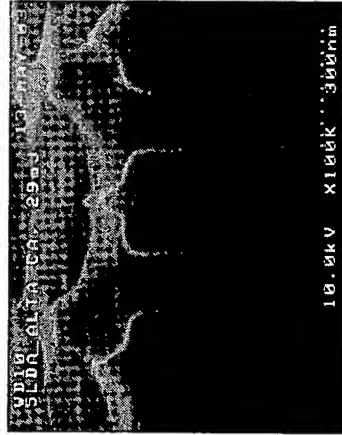


5LGA / SO(40s) + CA + N2/O2 PET (30/10) + cap
Si ARC top gently oxidized; Eqvt. to prev. N2/H2 PET





Litho

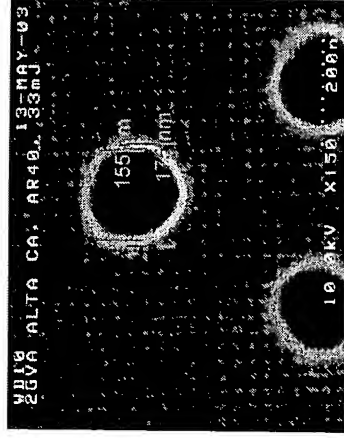


30s SO (140 mT, 750/750 W)
45s CA
30/10s N2/H2 PET

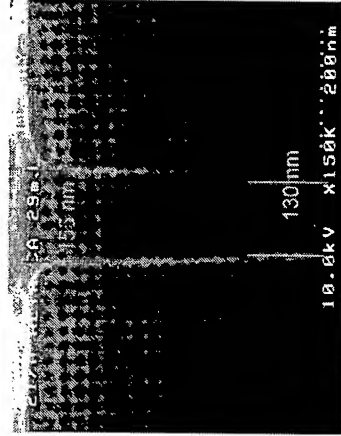
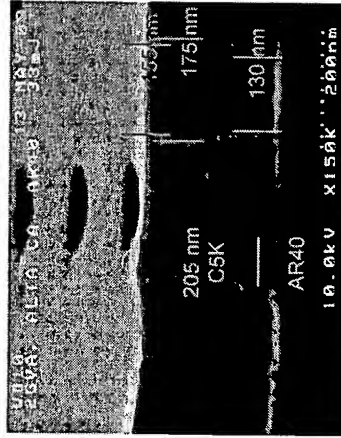
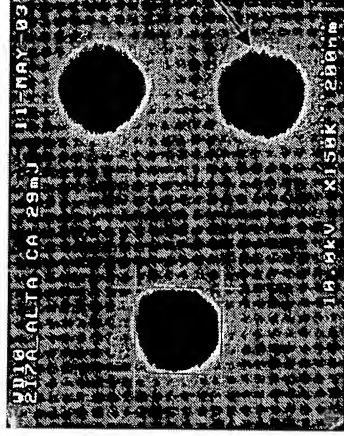
30s SO
45s CA
30/10s N2/H2 PET

Previous results w/ similar integration scheme
Must optimize Si-ARC open time; long overetch hurts "CD shrink" but might help w/ removal

Litho



Etch



SO + CA + N2/H2 PET + CAP

Current approach has tendency to roughen

Some Recipes

| | |
|--------------|---|
| SO: | 30s, 110mT, 750/1000W, 300/150/5/5/5=Ar/N2/C4F8/O2/CH3F |
| CA: | 45s, 86mT, 1000/2000W, 140/100/6.5/6=Ar/CO/C4F8/O2 |
| N2/H2 PET: | 30s, 380mT, 800/0W, 600/200=N2/H2 |
| | 10s, 380mT, 800/200W, 600/200=N2/H2 |
| N2/O2 PET: | 30s, 380mT, 800/0W, 500/100=N2/O2 |
| | 10s, 380mT, 800/200W, 500/100=N2/O2 |
| SiARC STRIP: | 60s, 400mT, 800/200W, 600/200/20=N2/H2/CH3F |
| PR STRIP: | 45s, 800mT, 800/0W, 800=O2 |
| | 15s, 800mT, 800/200W, 800=O2 |
| CAP: | 4s, 170mT, 0/500W, 150/20/30/20=Ar/CF4/O2/CH3F |
| | 16s, 170mT, 500/100W, 150/0/30/20=Ar/CF4/O2/CH3F |

Focus Items

- N_2/O_2 PET and N_2/H_2 PET w/o bias power approaches promising
 - Modify $\text{N}_2\text{-O}_2$ ratio
 - Modify $\text{N}_2\text{-H}_2$ ratio ...
- CD shrink hurt by overetching Si ARC
 - Must characterize
 - Minimize Si ARC open time
- Strip/CD shrink properties might change at smaller dimensions
 - Answer w/ 300 mm

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